VX-400 OPERATING MANUAL

BEFORE YOU BEGIN

Battery Installation and Removal

Refer to the illustration below showing the rear panel of the VX-400 and its battery pack.

- To install the battery, align the mounting slots on the upper side of the battery nest of the rear panel with the corresponding lugs of the battery, then insert the battery into the battery nest, then close the latch until it locks in place with a "Click."
- To remove the battery, turn the radio off and remove any protective cases. Open the latch on the bottom of the radio, then slide the battery downward and out from the radio.

Caution: Do not attempt to open any of the rechargeable Ni-Cd packs, as they could explode if accidentally short-circuited.

Low Battery Indication

- As the battery discharges during use, the voltage gradually becomes lower. When the battery voltage reaches 6.0 volts, substitute a freshly charged battery and recharge depleted pack. The TX/BUSY indicator on the top of the radio will blinks *red* when the battery voltage is low.
- Avoid recharging Ni-Cd batteries often with little use between charges, as this can degrade the charge capacity. We recommend that you carry as extra, fully-charged pack with you so the operational battery may be used until depletion (this "deep cycling" technique promotes better long-term battery capacity).

OPERATION

Preliminary Steps

- Install a charged battery pack onto the transceiver, as described previously.
- Screw the supplied antenna onto the Antenna jack. Never attempt to operate this transceiver without an antenna connected.
- If you have a Speaker/Microphone, we recommend that it not be connected until you are familiar with the basic operation of the VX-400.

Operation Quick Start

- To turn the radio on, press and hold the orange **PWR** button for 2 second.
- *Pull and turn* the top panel's **CH** selector knob to choose the desired operating channel.
- Rotate the top panel's **VOL** knob to set the volume level. If no signal is present, press the **MONITOR** button (the middle button on the left side); background noise will now be heard, and you may use this to set the **VOL** knob for the desired audio level. Press the **MONITOR** button again to quite the noise and resume normal (quiet) monitoring.
- To transmit, press and hold the **PTT** switch. Speak into the microphone area of the front panel grille (lower right-hand corner) in a normal voice level. To return to the Receive mode, release the **PTT** switch.
- If a Speaker/Microphone is available, remove the rubber cap and its screw from the right side of the transceiver, then plugged . Hold the speaker grille up next to your ear while receiving. To transmit, press the **PTT** switch on the Speaker/Microphone, just as you would on the main transceiver's body. Note that save the for use without the Speaker/Microphone.
- Press the top panel's **ACC** button to activate one of the "Pre-Programmed Functions" which may have been enabled at the time of programming by the dealer. See the next section for details regarding the available features.

VX-400V Alignment

Introduction

The VX-400 is carefully aligned at the factory for the specified performance across the frequency range specified for each version. Realignment should therefore not be necessary except in the event of a component failure, or altering version type. All component replacement and service should be performed only by an authorized Yaesu representative, or the warranty policy may be void.

The following procedures cover the sometimes critical and tedious adjustments that are not normally required once the transceiver has left the factory. However, if damage occurs and some parts subsequently are placed, realignment may be required. If a sudden problem occurs during normal operation, it is likely due to component failure; realignment should not be done until after the faulty component has been replaced.

We recommend that servicing be performed only by authorized Yaesu service technicians who are experienced with the circuitry and fully equipped for repair and alignment. Therefore, if a fault is suspected, contact the dealer from whom the transceiver was purchased for instructions regarding repair. Authorized Yaesu service technicians realign all circuits and make complete performance checks to ensure compliance with factory specifications after replacing any faulty components.

Those who do undertake any of the following alignments are cautioned to proceed at their own risk. Problems caused by unauthorized attempts at realignment are not covered by the warranty policy. Also, Yaesu reserves the right to change circuits and alignment procedures in the interest of improved performance, without notifying owners.

Under no circumstances should any alignment be attempted unless the normal function and operation of the transceiver are clearly understood, the cause of the malfunction has been clearly pinpointed and any faulty components replaced, and realignment determined to be absolutely necessary.

The following test equipment (and thorough familiarity with its correct use) is necessary for complete realignment. Correction of problems caused by misalignment resulting from use of improper test equipment is not covered under the warranty policy. While most steps do not require all of the equipment listed, the interactions of some adjustments may require that more complex adjustments be performed afterwards.

Do not attempt to perform only a single step unless it is clearly isolated electrically from all other steps. Have all test equipment ready before beginning, and follow all of the steps in a section in the order presented.

Required Test Equipment

- ❒ RF Signal Generator with calibrated output level at 200MHz
- ❒ Deviation Meter (linear detector)
- ❒ In-line Wattmeter with 5% accuracy at 200MHz
- ❒ 50-Ω RF Dummy Load with power rating 10W at 200MHz
- ❒ Regulated DC Power Supply (standard 7.5V DC, 3A)
- ❒ Frequency Counter with 0.2ppm accuracy at 200MHz
- ❒ AC Voltmeter
- ❒ DC Voltmeter
- ❒ VHF Sampling Coupler
- ❒ IBM PC / compatible Computer with Microsoft DOS v3.0 or later operating system
- ❒ Yaesu CT-42 Connection Cable & Alignment program

Alignment Preparation & Precautions

A 50-Ω RF Dummy Load and in-line wattmeter must be connected to the main antenna jack in all procedures that call for transmission, except where specified otherwise. Correct alignment is not possible with an antenna.

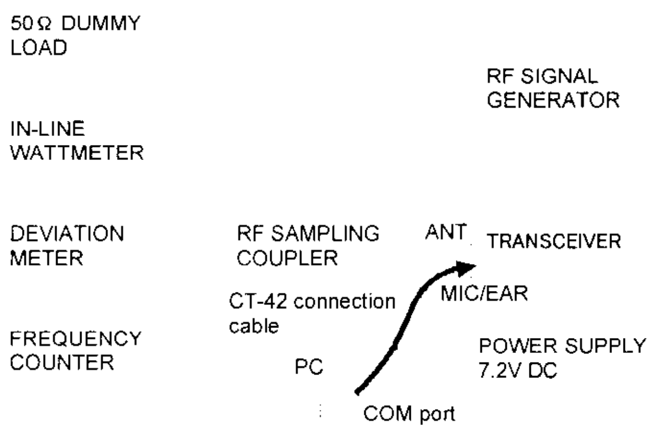
After completing one step, read the following step to determine whether the same test equipment will be required. If not, remove the test equipment (except dummy load and wattmeter, in connected) before proceeding.

Correct alignment requires that the ambient temperature be the same as that of the transceiver and test equipment, and that this temperature be held constant between 20 and 30°C (68 ~ 86 °F). When the transceiver is brought into the shop from hot or cold air, it should be allowed time to come to room temperature before alignment.

Whenever possible, alignments should be made with oscillator shields and circuit boards firmly affixed in place.
Also, the test equipment must be thoroughly warmed up before beginning.

Note: *Signal levels in dB referred to in the alignment procedure are based on 0dBμ EMF = 1μV.*

Setup the test equipment as shown for transceiver alignment, apply 7.5V DC power to the transceiver. Refer to the drawings above for Alignment Points.



The transceiver must be programmed for use in the intended system before alignment is attempted. The RF parameters are loaded from the file during the alignment process.

In order to facilitate alignment over the complete switching range of the equipment it is recommended that the channel data in the transceiver is preset as the chart below.

Channels	Frequency (Simplex)	
	Ver. A	Ver. C
LOW	134.000	146.000
MID	147.000	160.000
HIGH	160.000	174.000

The alignment mode is accessed by "Alignment mode" command from the computer whilst switching on. And it is operated by the alignment tool automatically.

During the alignment mode, normal operation is suspended. Use the alignment tool program running on PC.

Alignment of PLL Reference Frequency

Set up the test equipment as shown above for transmitter alignment. Hold the supply voltage constant 7.5V for all steps.
Select the MID channel and key the transmitter. Adjust TC1001 on the back of the body, if necessary, so the counter frequency is within 100Hz of the channel center frequency for the transceiver version. Also verify that the HIGH and LOW channels are also within tolerance.

Back of the body

This is the trimmer TC1001

The alignment tool outline

Installation the tool

This alignment tool consists, MS-DOS based, only one execute file " align400.exe " . You make a directly as you think fit, and copy this file. That is all of the installation process.

Boot the tool

Change directly and input in command line, " align400 [enter] ", and boot the alignment tool.

Enter to the alignment mode

To enter the alignment mode, turn off the power of the transceiver, and press [F10] to start a countdown 10 sec. You have to power on the transceiver while countdown. If entry succeed, the transceiver generate a beep " p-p-p ".

Action of the switches

When the transceiver is in alignment mode, the action of PTT, MON. Dial is ignored. All of the action is remote controlled by PC.

Basic sequence

The data displayed in screen of this tool is temporary data, and there is fear that the consistence of the displayed data and the data in the transceiver is failure when you do not keep the sequence which is specified below.

basic sequence

1. Enter the alignment mode
2. Data upload
3. Align data
4. Data download

When finish the alignment one parameter, the tool ask you " Update this data? ". If you select "Y", the temporary data is updated.

Next it ask you " Download this result to transceiver? ". If you select "Y", the tool download data to the transceiver.

Menu of the tool

[1] *Fundamentals*

In this section, the parameters are in common with all the channels. " Tx high power ", " max dev. " and " sub audio dev. " can be trimmed at each channel. Each parameter changed up/down by [[illegible]]/[[illegible]], and fixed by input [R] at appropriate value.

<u>Tx :</u>

[T] Tx power

- [0] High

This parameter is to align Tx High power (5W). Select the highest frequency channel in alignment range, and If you input [0], start Tx.

- [1] L1

Align the L1 power (100mW) similar method to " High ".

- [2] L2

Align the L1 power (1W) similar method to " High ".

- [3] L3

Align the L1 power (2.5W) similar method to " High ".

[D] maximum dev.

- [S] Start alignment

This parameter is to align the maximum deviation. Select the middle frequency channel in alignment range, and If you input [s], start Tx and 1kHz modulation.

[C] sub audio dev.

- [S] Start alignment

This parameter is to align the sub audio deviation. Select the middle frequency in alignment range and enabled sub audio signalling channel, and If you input [s], start Tx and sub audio modulation.

<u>Rx :</u>

[U] auto tuning

This parameter is to tune all channels. The tune of the VX-400 RF circuit is depend on its firmware, and execute this alignment, all channel is tuned appropriately.

Set the SG output level to +30dBμ EMF (32μV), and obey the message. The channels must be set to Low, Middle and High each other before execute this alignment.

[N] NSQL

This data is sampled noise level for Noise Squelch.

- [Z] Tight

This parameter is to align the noise level in squelch level 12 (channel parameter).

Set the SG output level to -3dBμ EMF (0.35μV), and obey the message.

- [X] Threshold

This parameter is to align the noise level in squelch level 1.

Set the SG output level to -12dBμ EMF (0.125μV), and obey the message.

[I] RSSI

- [Z] RSSI SQL

This parameter is the RSSI level for RSSI squelch.

Set the SG output level to +3dBμ EMF (0.7μV), and obey the message.

- [X] Tx save

This parameter is the RSSI level for Tx save activity.

Set the SG output level to +15dBμ EMF (2.8μV), and obey the message.

[V] BATT

This parameter is battery level for battery warning (6V) and protect the backup memory (5.5V).

[2] *Channels*

The following parameters are set every channel.

<u>**Tx trim :**</u>

[T] Tx power High

This parameter is to trim Tx High power in displayed channel.

[X] max dev.

This parameter is to trim maximum deviation in displayed channel.

[C] sub audio dev.

This parameter is to trim sub audio deviation in displayed channel.

Rx :

[U] manual tuning

This parameter is to tune displayed channel by manual.

[S] squelch level

This parameter is to set the squelch level. This is equivalent to a squelch volume of the popular transceiver.

Other :

[F] Tx/Rx frequency

This parameter is to set the Tx/Rx frequency.

[A] reboot transceiver

This parameter is to reset and start the transceiver.

VX-400V Circuit Description

1. Receive Signal Path

Incoming RF from the antenna jack is delivered to the RF Unit and passes through a low-pass filter and high-pass filter consisting of coils L1001, L1002, L1003, L1005, L1006 & L1007, capacitors C1006, C1007, C1014, C1022, C1027, C1036, C1054, C1058, C1060 & C1064 and antenna switching diode D1007 (RLS135).

Signals within the frequency range of the transceiver are then amplified by Q1024 (2SC5226-4/5) and enter a varactor-tuned band-pass filter consisting of coils L1010, L1013 & L1015, capacitors C1091, C1104, C1107, C1109, C1112, C1115, C1122, C1123, C1124, C1128, C1133 & C1136 and diodes D1023, D1024 & D1026 (all HVU350) before first mixing by Q1036 (SGM2016).

Buffered output from the VCO is amplified by Q1032 (2SC52264/5) to provide a pure first local signal between 112.3 and 152.3 MHz for injection to the first mixer Q1036 (SGM2016). The 21.7 MHz first mixer product then passes through monolithic crystal filters XF1001, XF1002 (21M12B3, 7.5 kHz BW) to strip away all but the desired signal, which is then amplified by Q1043 (2SC4215Y).

The amplified first IF signal is applied to FM IF subsystem IC Q1040 (TA31136FN), which contains the second mixer, second local oscillator, limiter amplifier, noise amplifier, and S-meter amplifier.

A second local signal is generated by PLL reference / second local oscillator Q1022 (2SC2620QB) from 21.25 MHz crystal X1001 to produce the 450 kHz second IF when mixed with the first IF signal within Q1040.

The second IF then passes through the ceramic filter CF1001 (SFPC450E) ,CF1002 (CFWM450G: only Narrow Channel) to strip away unwanted mixer products, and is applied to the limiter amplifier in Q1040, which removes amplitude variations in the 450kHz IF, before detection of the speech by the ceramic discriminator CD1001(CDBC450CX24).

Detected audio from Q1040 is applied to Q1047 (AK2341) and audio low-pass filter, and then past the volume control to the audio amplifier Q1011 (TDA7233D), providing up to 0.5 Watts to the optional headphone jack or 4-Ω loudspeaker.

2. Squelch Control

The squelch circuitry consists of a noise amplifier & band-pass filter within Q1040, and noise detector D1035 (DA221).

When no carrier received, noise at the output of the detector stage in Q1040 is amplified and band-pass filtered by the noise amplifier section of Q1040 and the network between pins 7 and 8, and then rectified by D1035.

The resulting DC squelch control voltage is passed to pin 75 of the microprocessor Q1033. If no carrier is received, this signal causes pin 15 of Q1033 to go low and pin 32 to go high. Pin 15 signals Q1012 (IMD10A) and Q1015 (UMD2N) to disable the supply voltage to the audio amplifier Q1011, while pin 32 makes Q1021 (UMA2N) hold the green (Busy) half of the LED off, when pin 15 is low and pin 32 is high.

Thus, the microprocessor blocks output from the audio amplifier, and silences the receiver while no signal is being received, and during transmission.

When a carrier appears at the discriminator, noise is removed from the output, causing pin 75 of Q1033 to go low and the microprocessor to blink the busy LED via Q1033.

The microprocessor then checks the DTMF decoder chip on the Optional Unit, the CTCSS and the CDCSS code for DTMF or CTCSS or CDCSS code squelch information, if enabled, respectively. If not transmitting and CTCSS or CDCSS is not activated, or if the received tone or code matches that programmed, the microprocessor stops scanning, if active, and allows audio to pass through the audio amplifier Q1011 (TDA7233D) to the loudspeaker by enabling the supply voltage to it via Q1012 and Q1015.

3. Transmit Signal Path

Speech input from the microphone is amplified in Q1009 (NJM2902V) after there is a filter and is sent to Optional Unit. The audio which returned from Optional Unit passes Q1009 (NJM2902V) to be pre-emphasized.

The processed audio is then mixed with a CTCSS tone generated by Q1047 (AK2341) and delivered to D1027 (1SS314) for frequency modulating the PLL carrier up to ± 5kHz from the unmodulated carrier at the transmitting frequency.

If an external microphone is used, PTT switching is controlled by Q1001 (UMZ2N), which signals the microprocessor when the impedance at the microphone jack drops.

If a CDCSS code is enabled for transmission, the code is generated by microprocessor Q1033 and delivered to D1016 (HVU202A) for CDCSS modulating.

If DTMF is enabled for transmission, the tone is generated by the microprocessor Q1033 and applied to the splutter filter section in place of speech audio. Also, the tone is amplified for monitoring in the loudspeaker.

The modulated signal from the VCO Q1038 (2SC2531C8/C9) is buffered by Q1039 (2SC2531C8/C9) and amplified by Q1032 (2SC5226-4/5). The low-level transmit signal is then applied to the PA module Q1007 for final amplification up to 5 watts output power.

The transmit signal then passes through the antenna switch D1007 (RLS135) and is low-pass filtered to suppress away harmonic spurious radiation before delivery to the antenna.

3-1 Automatic Transmit Power Control

RF power output from the final amplifier is sampled by C1018, C1025 and is rectified by D1010 (1SS321). The resulting DC is fed back through Q1018 (NJM2904V) to the PA module, and thus the power output.

The microprocessor selects either high or one of three low power levels.

3-2 Transmit Inhibit

When the transmit PLL is unlocked, pin 2 of PLL chip Q1025 goes to a logic low. The resulting DC unlock control voltage is passed to pin 78 of the microprocessor Q1033. While the transmit PLL is unlocked, pin 54 of Q1033 remains low, which then turns off the Automatic Power Controller Q1008 and Q1018 (UMC5N,NJM2904V) to disable the supply voltage to the PA module Q1007, disabling the transmitter.

3-3 Spurious Suppression

Generation of spurious products by the transmitter is minimized by the fundamental carrier frequency being equal to final transmitting frequency, modulated directly in the transmit VCO. Additional harmonic suppression is provided by a low-pass filter consisting of L1001, L1002 & L1003 and C1006, C1007, C1014, C1022, C1027 & C1036, resulting in more than 60 dB of harmonic suppression prior to delivery to the antenna.

4. PLL Frequency Synthesizer

PLL circuitry on the Main Unit consists of VCO Q1038 (2SC2531C8/C9) and VCO buffers Q1039 (2SC2531C8/C9), Q1034 (2SC4245) ; PLL subsystem IC Q1025 (MC145192DT), which contains a reference divider, serial-to-parallel data latch, programmable divider, phase comparator, charge pump, and a power saver circuit.

Stability is maintained by a regulated 3 V supply via Q1023 (2SB1132Q) to Q1022, temperature compensating thermistor and capacitors associated with the 21.25 MHz frequency reference crystal X1001.

While receiving, VCO Q1038 oscillates between 112.3 and 152.3 MHz according to the transceiver version and the programmed receiving frequency. The VCO output is buffered by Q1039, Q1034 and applied to the prescaler section of Q1025. There the VCO signal is divided by 64 or 65, according to a control signal from the data latch section of Q1025, before being applied to the programmable divider section of Q1025.

The data latch section of Q1025 also receivers serial dividing data from the microprocessor Q1033, which causes the pre-divided VCO signal to be further divided in the programmable divider section, depending upon the desired receive frequency, so as to produce a 5 kHz or 6.25 kHz derivative of the current VCO frequency.

Meanwhile, the reference divider section of Q1025 dividers the 21.25 MHz crystal reference from the reference oscillator Q1022, by 4250 (or 3400) to produce the 5 kHz (or 6.25 kHz) loop reference (respectively).

The 5 kHz (or 6.25 kHz) signal from the programmable divider (derived from the VCO) and that derived from the reference oscillator are applied to the phase detector section of Q1025, which produces a pulsed output with pulse duration depending on the phase difference between the input signals.

This pulse train is filtered to DC and returned to the varactor D1028 (HVU350). Changes in the level of the DC voltage applied to the varactor, affect the reference in the tank circuit of the VCO according to the phase difference between the signals derived from the VCO and the crystal reference oscillator.

The VCO is thus phase-locked to the crystal reference oscillator. The output of the VCO Q1038, after buffering by Q1039 and amplification by Q1032, is applied to the first mixer as described previously.

For transmission, the VCO Q1038 oscillates between 134 and 174 MHz according to the model version and programmed transmit frequency. The remainder of the PLL circuitry is shared with the receiver. However, the dividing data from the microprocessor is such that the VCO frequency is at the actual transmit frequency (rather than offset for IFs, as in the receiving case). Also, the VCO is modulated by the speech audio applied to D1027 (1SS314), as described previously.

Receive and transmit buses select which VCO is made active by Q1031 (DTC144EE). When the power saving feature is active, the microprocessor periodically signals the PLL IC to conserve power and shortens lock-up time.

5. Miscellaneous Circuits

5-1 Push-To-Talk Transmit Activation

The PTT switch on the microphone is connected to pin 3 of microprocessor Q1033, so that when the PTT switch is closed, pin 54 of Q1033 goes high. This signals the microprocessor to activate the TX / RX controller Q1005 (UMG2N), which then disables the receiver by disabling the 5 V supply bus at Q1050 (DTA143EU) to the front-end, FM IF subsystem IC Q1040 and receiver VCO circuitry.

At the same time, Q1002 (XP1501), Q1003 (2SB1132Q) activates the transmit 5V supply line to enable the transmitter.